FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NO. JP000026
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. Application No. (if known, see 37 CFR 1.5) 09/889088
INTERNATIONAL APPLICATION NO. PCT/EP00/11288	INTERNATIONAL FILING DATE November 10, 2000	PRIORITY DATE CLAIMED November 12, 1999 October 30, 2000

TITLE OF INVENTION
LIQUID CRYSTAL DISPLAY DEVICE

APPLICANT(S) FOR DO/EO/US
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Applicant(s) herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.

3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [ ] copy of the International Application as filed (35 U.S.C. 371 (c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).

6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2))

7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendment to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.

12. [X] An assignment document for recording. A separate cover sheet is compliance with 37 C.F.R. 3.28 and 3.31 is included.

13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND OR SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information:

    6 sheets of Drawings
    X Authorization Pursuant to 37 CFR § 1.136(a)(3) and to Charge Deposit Account
    X 2 Powers of Attorney by Akira Kamiya dated April 18, 2001

CERTIFICATE OF MAILING

[X] Express Mail Mailing Label No. EL686948728US
Date of Deposit July 11, 2001

I hereby certify that this paper and fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Elissa DeLuccy
Typed Name

Elissa DeLuccy
Signature

11 JUL 2001

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/889088	PCT/IB	PH

17 [X] The following fees are submitted:

BASIC NATIONAL FEE (37 C.F.R. 1.492(A)(1)-(5)):	CALCULATIONS (PTO USE ONLY)
Search Report has been prepared by the EPO or JPO $860.00	
International preliminary-examination fee paid to USPTO (37 C.F.R. 1.482) $690.00	
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) $750.00	
Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO $970.00	
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $ 96.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00

Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				$	
CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE	
Total Claims	8 - 20 =			X $ 18.00	$
Independent claims	1 - 3 =			X $ 80.00	$
MULTIPLE DEPENDENT CLAIMS (if applicable)				+ $270.00	$
TOTAL OF ABOVE CALCULATIONS =					$ 860.00
Reductions by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 C.F.R. 1.9, 1.27, 1.28)					$
SUBTOTAL =					$ 860.00
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)). +					$
TOTAL NATIONAL FEE =					$ 860.00
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28,3.31). $40.00 per property +					$ 40.00
TOTAL FEES ENCLOSED =					$ 900.00
				Amount to be refunded	$
				charged	$

a. [ ] A check in the amount $_____ to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. 14-1270 in the amount of $900.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fee, with the exception of the Base Issue Fee, which may be required, or credit any overpayment to Deposit Account No. 14-1270. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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(SIGNATURE)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of HIRANO ET AL

Atty. Docket JP000026

Serial No.

Group Art Unit

Filed: CONCURRENTLY

Ex.

Title: LIQUID CRYSTAL DISPLAY DEVICE

Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to calculation of the filing fee and examination, please amend the above-identified application as follows:

IN THE CLAIMS

Please amend the claims as follows:

4. (amended) A liquid crystal display apparatus according to claim 1 characterized in that: when α, β and n are predetermined real numbers and when a maximum value which digital values of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel can take is defined as MAX, said function of $w=f(Ymin, Ymax)$ is represented by a function of $W=Max*\{(Ymiu+\alpha)+(MAX+\beta)\}^n$ by which a digital value for driving said luminance intensifying subpixel is obtained.

5. (amended) A liquid crystal displaying apparatus according to claim 1 characterized in that: when a digital value of any of said

red inputting subpixel, said green inputting subpixel and said blue inputting subpixel is a zero value, a value of said W is zero.

6. (amended) A liquid crystal display apparatus according to claim 1 characterized in that: said apparatus comprises:

storing means for storing a plurality of kinds of functions each represented by said function of W=f(Ymin, Ymax); and

selecting means for selecting any of said plurality of kinds of functions represented by said function of W=f(Ymin, Ymax) stored by said storing means.

7. (amended) A liquid crystal display apparatus according to claim 1, wherein said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged to form a main pixel unit without using said subpixel for luminance in accordance with a predetermined control signal, thereby to enable the apparatus to be used as a liquid crystal display apparatus capable of color-displaying.

8. (amended) A liquid crystal display apparatus according to claim 1, wherein it is made possible based on a predetermined control signal to perform an image display in which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged as a main pixel unit without using said subpixel for luminance, and at the same time an image display in which said red outputting subpixel, said green outputting

subpixel and said blue outputting subpixel are arranged as a main pixel unit using said subpixel for luminance.

REMARKS

The foregoing Preliminary Amendment to the claims were made solely to avoid filing the claims in the multiple dependant form so as to avoid the additional filing fee.

The claims were not amended in order to address issues of patentability and Applicants respectfully reserve all rights they may have under the Doctrine of Equivalents. Applicants furthermore reserve their right to reintroduce subject matter deleted herein at a later time during the prosecution of this application or continuing applications.

Respectfully submitted,

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Attorney
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APPENDIX

Amended Claims

4. (amended) A liquid crystal display apparatus according to ~~any of Claims 1 and 3~~ claim 1 characterized in that: when α, β and n are predetermined real numbers and when a maximum value which digital values of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel can take is defined as MAX, said function of w=f(Ymin, Ymax) is represented by a function of $W=Max*\{(Ymiu+\alpha)+(MAX+\beta)\}^n$ by which a digital value for driving said luminance intensifying subpixel is obtained.

5. (amended) A liquid crystal displaying apparatus according to ~~any one of Claims 1 to 4~~ claim 1 characterized in that: when a digital value of any of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel is a zero value, a value of said W is zero.

6. (amended) A liquid crystal display apparatus according to ~~any one of Claims 1 to 5~~ claim 1 characterized in that: said apparatus comprises:

storing means for storing a plurality of kinds of functions each represented by said function of W=f(Ymin, Ymax); and

selecting means for selecting any of said plurality of kinds of functions represented by said function of W=f(Ymin, Ymax) stored by said storing means.

7. (amended) A liquid crystal display apparatus according to ~~any one of claims 1 to 6~~claim 1, wherein said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged to form a main pixel unit without using said subpixel for luminance in accordance with a predetermined control signal, thereby to enable the apparatus to be used as a liquid crystal display apparatus capable of color-displaying.

8. (amended) A liquid crystal display apparatus according to ~~any one of claims 1 to 6~~claim 1, wherein it is made possible based on a predetermined control signal to perform an image display in which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged as a main pixel unit without using said subpixel for luminance, and at the same time an image display in which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged as a main pixel unit using said subpixel for luminance.

Liquid crystal display device

This invention relates to a liquid crystal display apparatus capable of color displaying.

In recent years, a liquid crystal display apparatus capable of color displaying is widely used as a display apparatus, for example, for a personal computer, a video camera and a car navigation system.

A Liquid crystal display apparatus of RGBW type (hereinafter referred to as a RGBW type liquid crystal display apparatus) in which a transparent filter (W) is arranged in addition to a RGB filter of the conventional RGB type has been proposed in Japanese Patent Application Laid-open No.10998/1998, which relates to a method for improving luminance of a pixel of a liquid crystal panel of this liquid crystal display apparatus.

However, even though attempting improvement of luminance of the liquid crystal panel by merely adding the transparent filter, a white color is mixed in all display colors if luminance of a part of pixels of the transparent filter is not controlled in an independent manner appropriately, so that color purity (saturation) is degraded, and the image with a display color which is not intended, which is different from an original image is destined to be displayed.

Accordingly, the first object of the invention is to provide a RGBW type liquid crystal display apparatus capable of properly improving luminance of the image output from the liquid crystal panel by controlling luminance of the pixel of the transparent filter in an independent manner appropriately under a predetermined calculation when establishing luminance of the liquid crystal panel.

According to the liquid crystal display apparatus described in claim 1, said predetermined calculation processing by said data calculating means obtains said digital value for driving said luminance-intensifying subpixel by a function of W=f(Ymin, Ymax) in case where said digital value of said luminance-intensifying pixel is defined as W and Ymin

and Ymax of said digital values of each of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel are respectively defined as a minimum value and a maximum value, whereby said first object can be achieved.

According to the liquid crystal display apparatus described in claim 2, said function of W=f(Ymin,Ymax) is directed to a function which is monotonously increased as said Ymin value or said Ymax value becomes larger, whereby said first object can be achieved.

According to the liquid crystal display apparatus described in claim 3, said function of W=f(Ymin,Ymax) is directed to a function where said Ymin is a variable value and said Ymax is a constant value and a function which is monotonously increased as said Ymin value becomes larger, whereby said first object can be achieved.

According to the liquid crystal display apparatus described in claim 4, in a case where α, β and n are predetermined real numbers and a maximum value which can be adopted regarding as said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel, is defined as MAX, said function of w=f(Ymin, Ymax) being represented by a function of $W=Max*\{(Ymin+\alpha)+(MAX+\beta)\}^n$ by which a digital value for driving said luminance intensifying subpixel is obtained, whereby said first object can be achieved.

According to the liquid crystal display apparatus according to any of claims 1 and 4,in a case where a digital value of any of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel is directed to zero value, a value of said W is directed to zero value, whereby said first object can be achieved.

According to the liquid crystal display apparatus described in claim 6, said apparatus comprises:

storing means for storing a plurality of kinds of functions represented by said function of W=f(Ymin, Ymax); and

selecting means for selecting any of said plurality of kinds of functions represented by said function of W=f(Ymin, Ymax) stored by said storing means, whereby said first object can be achieved.

According to the liquid crystal display apparatus described in claim 7, wherein said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are constituted as a main pixel unit without using said subpixel for luminance, thereby to be able to use as a liquid crystal display apparatus capable of color-displaying, whereby the second object can be achieved.

According to the liquid crystal display apparatus described in claim 8, wherein it is made possible to perform an image display which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are constituted as a main pixel unit without using said subpixel for luminance, and an image display which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are constituted as a main pixel unit using said subpixel for luminance at same time, whereby the second object can be achieved.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is a block diagram showing a constitution of a liquid crystal display apparatus 100 of a preferred embodiment according to the invention;

Fig. 2 is a top plane view for illustrating an arrangement of a subpixel, a gate bus, and a source bus of a liquid crystal panel 1 shown in Fig.1;

Fig. 3 is a block diagram schematically representing a source driver 3 and a decoder 6 shown in Fig.1;

Fig. 4 is a chromaticity diaphragm using to illustrate a mathematical formula 2;

Fig. 5 is a graph of a calculated result obtained by using a mathematical formula 3;

Fig. 6 is a top plane view showing a modification of an embodiment shown in Fig. 2;

Fig. 7 is a top plane view showing a modification of an embodiment shown in Fig. 2; and

Fig. 8 is a block diagram representing a modification of an embodiment shown in Fig. 3.

Fig. 1 is a block diagram showing a constitution of a liquid crystal display apparatus 100 of one first embodiment according to this invention. This liquid crystal display apparatus 100 is provided with a liquid crystal panel 1. Fig. 2 is a top plane view schematically showing a horizontal portion of this liquid crystal panel 1. This liquid crystal

panel 1 is provided with row-like gate buses G1 to Gm (m: a natural number) and column-like source buses S1 to Sn (n: a natural number) as shown in Fig. 2. Moreover, the gate buses G1 to Gm are connected with the gate driver 2, and the source buses S1 to Sm are connected with the source driver 3.

Moreover, subpixels Lij of R (red), G (green), B (blue) or W (white (for reinforcement of luminance)) are arranged in meshes which the gate bus Gi and G1+1 (i=1 to m) and the source bus Sj and Sj+1 (j=1 to m) form.

Moreover, TFTs (thin film transistors) Qij are arranged in the vicinity of the intersections of the gate buses Gi and the source buses Sj. Furthermore, the gate bus Gi is connected with the gate of the TFT Qij, the source bus Sj with the source of TFTQij, and the display electrode of each subpixel Lij with the drain of the TFT Qij. Moreover, the electrode opposed to the display electrode of each subpixel Lij is a common electrode 12, and this common electrode 12 is connected with a voltage supply circuit (not shown).

Moreover, the color filter for the RGBW is arranged for each the subpixel Lij as follows, when the subpixels are arranged in a longitudinal stripe form as shown in Fig. 2 and one pixel is constituted from four subpixels of the RGBW.

R:Lij (i=1, 2, 3, ..., m-1, j=1, 5, 9,..., n-3)

G:Lij (i=1, 2, 3,..., m, j=2, 6, 10, ..., n-2)

B:Lij (i=1, 2, 3,..., m, j=3, 7, 11, ..., n-1)

W:Lij(I=1, 2, 3, ..., m-1, j=4, 8, 12, ..., n)

In this liquid crystal panel 1, these subpixels form a longitudinal stripe arrangement.

Moreover, a TFT substrate on which the subpixel electrode is formed, a color filter substrate on which the common electrode is formed and a glass substrate or the like, which are not shown, are arranged in a direction perpendicular to a panel surface of the liquid crystal panel 1, and a liquid crystal is filled in such a manner as to be sandwiched between these substrates. In the color filter substrate, although the red, green and blue semitransparent color filters are arranged respectively at a part corresponding to the above-described subpixel RGB, the color filter is not arranged at a part corresponding to the subpixel W, or the transparent filter is arranged.

Returning to Fig.1, the description of the liquid crystal display apparatus 100 will be continued. The Gate driver 2 and eight source drivers 3 are arranged around the liquid crystal panel 1. An amplifier, a DAC (a DA converter) and a latch, which are not shown, are arranged in each source driver 3. Moreover, this liquid crystal display apparatus 100 has a

signal control section 4. This signal control section 4 supplies a power supply voltage, as well as supplies control signals to the gate driver 2, the source driver 3, an image data holding section 5, and a decoder 6. The decoder 6 is connected with each source driver 3. Moreover, the image data holding section 5 in which each subpixel input data Ri, Gi, and Bi with eight bits of the red, green and blue colors of the image acquired in digitalized form are held is connected with this decoder 6.

Moreover, the liquid crystal display apparatus 100 comprises a reference potential generating circuit applying reference potential on the basis of a predetermined clock frequency to each source driver 3 (not shown).

The operation of the liquid crystal display apparatus100 shown in Fig. 1 will be described below.

The control signal is supplied from the signal control section 4 to the gate driver 2 and each source driver 3. The gate driver 2 transmits a signal for turning TFTQij into the on condition to each of gate buses (refer to Fig. 2) based on the control signal.

Moreover, subpixel outputting luminance data Ro, Go, Bo and Wo of eight bits are latched in the latch portion (not shown) of each source driver 3 based on the control signal, when the control signal is supplied to each source driver 3.

Moreover, these subpixel outputting luminance data Ro, Go, Bo and Wo of eight bits can be obtained as a result of performing the predetermined calculation (will be described later) by the decoder 6 for subpixel inputting data Ri, Gi, and Bi constituting the digital image which is held on the image data holding section 5.

Subpixel outputting luminance data Ro, Go, Bo and Wo latched in the above-description latch portion are output in order and are input to the DAC portion (not shown). Moreover, the control power supply 4 outputs a polarity control signal for controlling whether the DAC portion selects potential from positive polarity reference potential generated from the reference potential generating circuit or selects potential from negative polarity reference potential, and this polarity control signal is input to the DAC portion. The DAC portion selects potential corresponding to these W subpixels outputting luminance data Ro, Go, Bo and Wo from potential which is generated by the reference potential generating circuit based on the input polarity control signal and subpixel outputting luminance data Ro, Go, Bo and Wo.

When potential is selected by the DAC portion, the DAC portion divides a voltage of the selected potential by resistance division into several steps appropriately so as to obtain a desired gradation. The divided voltage is current-amplified by an amplifier and

transmitted to a corresponding one of the source buses S1 to Sn (refer to Fig. 2). When the TFT becomes on by the signal transmitted to one of the gate buses G1 to Gm, this signal of the potential transmitted to this source bus is transmitted to each subpixel electrode by way of this TFT.

According to this operation, potential corresponding to subpixel outputting luminance data is added to each subpixel electrode. Therefore, a voltage is supplied to the liquid crystal layer which is sandwiched between a common electrode and each subpixel electrode, and the liquid crystal layer is driven in response to potential added to each subpixel electrode, so that the image is displayed on the liquid crystal panel 1 by principle of additive color mixing.

The preferred embodiment in relation to calculation processing of the decoder 6 mentioned above will be described with reference to Fig.3 in further detail below. The decoder 6 acquires each input subpixel digital data Ri, Gi, and Bi of the red, green and blue colors of eight bits from the image data holding section 5 to output RGBW subpixel outputting luminance data Ro, Go, Bo and Wo from these Ri, Gi, and Bi to the source driver 3 as shown in Fig. 3.

On the other hand, the following processing is required in order to obtain W subpixel outputting luminance data Wo.

The decoder 6 is provided with a comparator 7 and a look-up table 8. The comparator 7 converts this value into dimensions of luminance data after comparing values of input subpixel digital data Ri, Gi, and Bi acquired as described above to select a minimum value Ymin of the values of these Ri, Gi, and Bi.

Next, the look-up table 8 converts the Ymin value thus selected and converted it into W subpixel outputting luminance data Wo by this comparator 7.

The conversion to W subpixel outputting luminance date Wo of the Ymin value described above can be realized easily by using PROM in which the calculated result of a mathematical formula 1 which is mentioned later, for each value of Ymin which changes from zero to 255 (in the case of 256-step gradation) is stored in a Ymin address. Furthermore, the control signal from the signal control section 4 to decoder 6 and memory or the like in which data is stored are not required if being a circuit constitution for only this object.

However, since a delay by some number of clocks is caused while the comparator and the look-up table outputs W subpixel outputting luminance data Wo after input subpixel data Ri, Gi, and Bi are input in the decoder 6, the long time can be required. At that time, output of RGB subpixel outputting luminance data Ro, Go and Bo is required to

be delayed within decoder 6 in synchronization with outputting of W subpixel outputting luminance data Wo.

As described above, the decoder 6 determines W subpixel outputting luminance data Wo from input subpixel data Ri, Gi, and Bi obtained from an input original image.

Furthermore, the above-mentioned mathematical formula 1 will be described. The mathematical formula 1 is an optional function which is are represented by Wo=f (Ymin, Ymax), when W subpixel outputting luminance data is taken as Wo, and a minimum value is taken as Ymin, a maximum value is taken as Ymax of the digital values respectively for each of a red inputting pixel, a green inputting pixel, and a blue inputting pixel.

A function which is monotonously increased as said Ymin value or said Ymax value becomes larger can be adopted as the function which is represented by this mathematical formula 1. For example, it is the function of $Wo= (Ymax* Ymin)/MAX^2$. Here, MAX is the largest value which can be taken, of the values of input luminance data of Ri, Gi and Bi.

Furthermore, $Wo=MAX*\{(MINRGB+\alpha)/(MAX+\beta)\}^n$ (hereinafter referred to this mathematical formula simply as a mathematical formula 2) is given as the other preferred examples of the mathematical formula 1. This mathematical formula 2 will be described in detail below. This mathematical formula 2 is the function in which a minimum value of RGB subpixel inputting luminance data which is output in the decoder 6 is defined as a variable, thereby to determine W subpixel outputting luminance data Wo.

In this mathematical formula 2, Wo is output luminance data for W subpixel, MAX is the largest value which can be taken, of the input luminance data value of Ri, Gi and Bi as is described above, and MINRGB is the minimum value which can be taken, of the input luminance data value of Ri, Gi and Bi. Moreover, α, β and n are optional real numbers.

The values of α, β and n are determined by optical characteristics such as luminance which is set as the target of the liquid crystal display apparatus 100. For example, the condition in which $\beta=0$ is obtained can be introduced from the condition in which Wo is made into MAX, that is, the condition that gives the largest luminance to the liquid crystal panel 1 of the liquid crystal display 100, when the minimum value MINRGB (Ymin) of input luminance data of Ri, Gi and Bi is MAX.

Moreover, the condition in which $\alpha=0$ and $\beta=0$ is obtained can be introduced from the condition that the contrast can not be degraded, which is concomitant with the liquid crystal display 100 inherently, since the condition in which Wo is made zero when the

minimum value MINRGB (Ymin) of input luminance data of Ri, Gi and Bi is zero, and the condition in which Wo=MAX is obtained when the minimum value MINRGB (Ymin) of input luminance data of Ri, Gi and Bi is MAX, under this condition.

Optionally, when the color to be displayed for the liquid crystal display apparatus 100 is 256 step gradation, MAX value is MAX=255.

The calculation by the mathematical formula 2 also can be realized using the look-up table (LUT) which the decoder 6 comprises as described above. Such look-up table can be built-in ASIC of the decoder 6 easily, and can be realized easily with PROM and EEPROM which have a storage capacity of 256 byte when each input of RGBW and luminance date are of eight bits, such a look-up table. The values of α and β described above are set in the look-up table in advance in accordance with the optical characteristics (luminance) which are desired in the liquid crystal display apparatus.

Here, the theory which is founded at determining the mathematical formula 2 will be described with reference to a chromaticity diaphragm in Fig. 4 complementarily below.

Now, when Ri, Gi, and Bi and each point in R, G, B and W on the chromaticity diaphragm in Fig. 4 are in the following relationship, that is, the relationship that it corresponds to the point R when being Ri=MAX and G=B=0, the point G when being G=MAX and R=B=0, the point B when being B=MAX and R=G=0, and furthermore, the point W when being Ri=MAX and R=G=B are satisfied, the following conclusion can be obtained. "When either of value of R, G and B is larger than zero, the chromaticity is inside the triangle RGB in Fig. 4." "Namely, the color is provided with a white (gray)-colored component, approaching the point W."

Furthermore, the following conclusion can be obtained with regard to W from the conclusion described above.

(1)"In the case of R=G=B, only luminance can be increased without change in chromaticity even though adding W thereto."

(2) "Since the triangle RGW represents the range of the color which the liquid crystal display apparatus can be expressed, W=0 is set, when at least any one of R, G and B is zero in order not to make this range narrow."

(3) "The chromaticity where either of R, G and B is larger approaches the point W as the minimum value of R, G and B becomes larger." "That is to say, the minimum value of R, G and B represents how the color is white." "Therefore, if W is given as the function of the minimum value of R, G and B, luminance can be increased without

excessively large changing the chromaticity where one pixel is constituted by three pieces of subpixel of R, G and B."

Accordingly, the mathematical formula 2 which can give W as the function of the minimum value (MINRGB) of R, G and B could be derived in view of the conclusions of items (1), (2) and (3) described above.

Next, some embodiments (example 1 to 3) that the decoder 6 determines Wo using this mathematical formula 2 will be described with reference to a graph of the mathematical formula 2 in Fig. 5 below.

Fig. 5 is a graph of the mathematical formula 2 in the case where the above-mentioned MINRGB value determined by the decoder 6 is taken as a variable of X axis, and Wo value being determine by substituting the MINRGB value into the mathematical formula 2 is taken as a variable of Y axis, when the number of maximum gradation of each pixel of the display image is 256-step gradation.

As example 1, the case where any one of the values of luminance data of Ri, Gi and Bi is zero will be described. In this case, since MINRGB=O, Wo=0 is obtained from calculation of the mathematical formula 2 (on X axis of the graph in Fig. 5). Namely, Wo=0 can be designed to realize, whereby color purity (saturation) can not be reduced in this case.

As example 2, the case which $\alpha=\beta=0$ and n=1 are set in the mathematical formula 2 will be described. In this case, since the mathematical formula 2 is transformed into Wo= MINRGB, the result which is represented by the straight line in Fig. 5 (example 2) can be obtained. Therefore, gamma(γ) characteristic of the original image before being input in the image data holding portion 5 can be held in this case. Moreover, the constitution of a circuit to be added is simple, and the scale of the constitution constituting the circuit also is needed in a small size.

As example 3, the case which "n" value is set larger than numerical value "1" in the mathematical formula 2 will be described. In this example 3, n=2 and $\alpha=\beta=0$ are set. Moreover, MAX=255 is set. From this setting, the mathematical formula 2 is represented with $Wo=255*(MINRGB/255)^n$ (hereinafter referred to this mathematical formula as "a mathematical formula 3"), and this mathematical formula 3 is represented with the graph of Fig. 5 (example 3).

As understood from the graph of this (example 3), the Wo value becomes larger suddenly as the MINRGB value is larger. That is to say, according to the calculation processing by this mathematical formula 2, a white display of approximately 100% to other display color can be realized in a glaring manner, since luminance (Wo) for W subpixel

becomes high suddenly, as MINRGB value approaches the maximum step number of gradation. As a result, radiance of a white cloud irradiated with the solar light which heretofore, has been realized by only CRT and, a display of a glittering luster of a metallic surface has come to be able to display.

Moreover, as understood from the graph of this (example 3), the graph of Wo is noticeable in the curved shape protruded downwardly (monotonously increased) in a variable region of the middle value which MINRGB value can take. As a result, luminance (Wo) for W subpixel can be suppressed in a halftone such as MINRGB=64 to 192, for example, and the original chromaticity (saturation) in the halftone can be held in the display image.

As described above, various images becomes possible by defining a constant of the mathematical formula 2 as required according to said embodiments. It may be designed to select such that the image which an user desires can be obtained from the exterior by storing the functions such as examples 1 to 3 described above for determining Wo in a plurality of pieces in the look-up table provided on the decoder 6 in advance.

As described above, according to said embodiments, appropriate W subpixel outputting luminance data can be determined in response to the image to be displayed by performing the calculation processing based on the mathematical formula 1 by the decoder 6. Moreover, the optical characteristics with various luminance desired in the liquid crystal display apparatus 100 can be provided by setting various functions in the look-up table provided on the decoder 6 in advance.

Next, as mentioned above, the constitution that the liquid crystal panel 100 can be used also as the RGBW type liquid crystal display and also as the RGB type liquid crystal display will be described with reference to a block diagram in Fig. 6 in which the constitution according to a block diagram in Fig. 3 is noted as a main part as a further embodiment.

A control signal Ci functioning as further one bit of switching control signal is added in addition to input signals Ri, Gi, and Bi in order to achieve this further embodiment, as shown in Fig. 6. This Ci signal is synchronized with clock frequency of the described-above input signals Ri, Gi, and Bi, and all the circuit in Fig. 6 performing a function for displaying RGBW is enabled, when this Ci signal is HIGH. On the other hand, CMP7 and LUT6 are skipped, Wo=0 is set, and the input signals Ri, Gi, and Bi are output as output signals Ro, Go, and Bo as it is, when this Ci signal is LOW.

According to this operation, displaying of either of RGB display or RGBW display becomes possible by switching HIGH and LOW of the Ci signal. Moreover, it may be designed to set such that Wo=0 is set merely in LUT8, when RGB display is desired.

Switching of the Ci signal may be performed through software by the PC which the liquid crystal display apparatus 100 is provided, or the switching may be designed to perform when pushing a short-cut-key or the like in a key board of the PC.

According to this operation, it can be used as the RGB type liquid crystal display apparatus since there is no necessity to brighten a white color in particular when preparing a text in an office work, on the other hand, it can be used as the RGBW type liquid crystal display apparatus, when it is desired to highlight a snow scene, brightness of a car polished with a wax sufficiently, and a cloud, or a white-colored text such a telop for an advertisement.

A part thereof can display the screen for RGBW, and another part can display the screen for RGB by using a window of the screen of the PC. In this case, it is constituted such that a pixel according to the Ci signal gives characterization on a pixel according to the input signals Ri, Gi, and Bi by each pixel unit , that is, the Ci signal can display the RGBW display at the pixel in the window screen of High and the Ci signal can display the RGB display at the pixel in the window screen of Low, for example. According to this constitution, for example, the screen which a luster obtained from a metallic surface of the car is highlighted can be displayed at the window screen of the half of the right side and a text document which a profile or the like of the car is written can be displayed at the window screen of the half of the left side by providing the liquid crystal display apparatus according to the invention on the PC at a sales office and an exhibition of the car for the advertisement. The text document can be displayed on the other side by weakening the white color and to make easy to read for observers rather than without highlighting a white color (luminance) so much, while taking advantage of a merit comprised in the RGBW screen.

Moreover, in the RGBW type liquid crystal display, an apparent difference in luminance of the white color where comparing with the RGB type liquid crystal display is recognized when observing the screen from a slightly distant position, whereby the RGBW type liquid crystal display apparatus according to the invention can show noticeable effects in the case that the observer observes a white-colored character such as a telop with the RGBW type liquid crystal display apparatus from a distant position, at the crowded exhibition, and the case or the like that the observer should observe the RGBW type liquid crystal display

from a distant position inevitably, which is provided on a wall surface or the like of a building.

Moreover, the inventions described in each claim should not be limited to each embodiment mentioned above, and various modifications can be adopted within the scope described in each claim as described below.

Some modifications will be described below.

(1) Modification 1: although in a preferred embodiment, subpixel RGBW has been aligned in the form of longitudinal stripe arrangement as shown in Fig. 2, it may be aligned in a form of a mosaic-shape as shown in Fig. 6. In this case, an individual form of the subpixel is approximately square.

(2) Modification 2: although in the described-above modifications 1, meshes of a net are formed by the source buses and the gate buses and, the individual subpixel is made to arrange in the meshes of the net one by one as shown in Fig.7, the gate bus may be wired by one piece every two steps of the subpixel, the source bus may be wired by two pieces between one step of subpixel as shown in Fig.7. According to such constitution, the number of the gate bus is the same as the prior RGB type, and a writing characteristic of the TFT would remain as it is the prior art. Moreover, according to the constitution, it has become unnecessary to sort a source signal every one row in the source driver 3, since a color of the subpixel which is connected with a piece of source bus becomes one kind.

(3) Modification 3: although the decoder 6 and the source driver 3 are formed as separated bodies as shown in Fig.3 in the described-above preferred embodiment, these may be arranged as an integrated structure of the decoder and the source driver by arranging the decoder in an entrance portion of the inside of the source driver, as shown in Fig.9. According to such constitution, an increase by the amount corresponding to luminance date for W subpixel in the number of data wiring in the printed circuit board can be avoided.

As described above, according to the liquid crystal display apparatus of this invention, luminance of the image displayed with the liquid crystal panel can be improved appropriately.

CLAIMS:

1. A liquid crystal display apparatus capable of color-displaying provided with crystal panel having, in each main pixel unit, a red outputting subpixel, a green outputting subpixel, a blue outputting subpixel and a luminance-intensifying subpixel characterized by comprising:

data calculating means for obtaining a digital value for driving a luminance-intensifying subpixel by carrying out a predetermined calculation processing using digital values respectively for a red inputting pixel, a green inputting pixel, and a blue inputting pixel which are obtained from an input image,

wherein said liquid crystal displaying apparatus driving the luminance-intensifying subpixel, the red outputting subpixel, the green outputting subpixel and the blue outputting subpixel by using said digital value for driving said luminance-idensifying subpixel obtained by said data calculating means and said digital values of said red, green and blue inputting subpixels, characterized in that: said predetermined calculation processing by said data calculating means obtains said digital value for driving said luminance-intensifying subpixel by a function of W=f(Ymin, Ymax) where said digital value of said luminance-intensifying pixel is defined as W, and a minimum value and a maximum value of said digital values of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel are respectively defined as Ymin and Ymax.

2. A liquid crystal display apparatus according to Claim 2, wherein said function of W=f(Ymin,Ymax) is directed to a function which is monotonously increased as said Ymin value or said Ymax value becomes larger.

3. A liquid crystal displaying apparatus according to Claim 1 characterized in that: said function of W=f(Ymin,Ymax) is directed to a function in which said Ymin is a variable value and said Ymax is a constant value and which is monotonously increased as said Ymin value becomes larger.

4. A liquid crystal display apparatus according to any of Claims 1 and 3 characterized in that: when α, β and n are predetermined real numbers and when a maximum value which digital values of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel can take is defined as MAX, said function of w=f(Ymin, Ymax) is represented by a function of $W=Max*\{(Ymiu+\alpha)+(MAX+\beta)\}^n$ by which a digital value for driving said luminance intensifying subpixel is obtained.

5. A liquid crystal displaying apparatus according to any one of Claims 1 to 4 characterized in that: when a digital value of any of said red inputting subpixel, said green inputting subpixel and said blue inputting subpixel is a zero value, a value of said W is zero.

6. A liquid crystal display apparatus according to any one of Claims 1 to 5 characterized in that: said apparatus comprises:

storing means for storing a plurality of kinds of functions each represented by said function of W=f(Ymin, Ymax); and

selecting means for selecting any of said plurality of kinds of functions represented by said function of W=f(Ymin, Ymax) stored by said storing means.

7. A liquid crystal display apparatus according to any one of claims 1 to 6, wherein said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged to form a main pixel unit without using said subpixel for luminance in accordance with a predetermined control signal, thereby to enable the apparatus to be used as a liquid crystal display apparatus capable of color-displaying.

8. A liquid crystal display apparatus according to any one of claims 1 to 6, wherein it is made possible based on a predetermined control signal to perform an image display in which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged as a main pixel unit without using said subpixel for luminance, and at the same time an image display in which said red outputting subpixel, said green outputting subpixel and said blue outputting subpixel are arranged as a main pixel unit using said subpixel for luminance.

ABSTRACT:

This invention relates to an RGBW-typed LCD wherein a proper luminous image can be displayed according to a predetermined calculation with a decoder where some predetermined calculation formulas are embedded. Further, not only RGBW image display but also RGW image display can be used by a predetermined controlling signal.

Fig.3

Combined Declaration For Patent Application and Power of Attorney (Continued)
(Includes Reference to PCT International Applications)

Attorneys Docket Number
PHJP000026 US

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) abnd/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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Michael E. Marion, Reg. No. 32,266
Edward M. Blocker, Reg. No. 30,245

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 if Title 18 of the United states Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203 **(Legal Representative)**
Satoshi Hirano	Masaru Yasui	5-11 Akihiko Miyazaki AKIHIKO MIYAZAKI
DATE 4 April 2001	DATE 4 April 2001	DATE 18 April 2001

SIGNATURE OF INVENTOR 204
Shuji Hagino
DATE 4 April 2001

PCT Petition
Assignment

09 889088

JC05 Rec'd PCT/PTO 24 AUG 2001

Power of Attorney

委任状

I, Akira KAMIYA of 15-4, Tobei-cho 3-chome, Anjo-shi, Aichi, Japan, am the heir to Takeo KAMIYA, my son, who was born on August 17, 1961, and deceased on March 6, 2000.

（本籍）日本国愛知県安城市東栄町３丁目１５番地４に所在の私、神谷 明は、昭和３６年８月１７日に生まれ、平成１２年３月６日に死去した私の息子、神谷 長生の相続人である。

Now I declare to instruct and authorize and as a consequence thereof to appoint as Administrator in the sense of the American and other Patent Acts:

私はここに、昭和３６年２月７日に生まれ、日本国神奈川県川崎市宮前区宮崎２－２－７チュリス宮崎台６０４に所在の管理者、宮崎 昭彦に、特に以下の事項を指示し、そしてこのことから、アメリカ及びその他の国の特許条約条の意味においての管理者として宮崎 昭彦を任命することを宣誓する。

Akihiko Miyazaki, administrator, living at 2-2-7-604, Miyazaki, Miyamae-ku, Kawasaki-shi, Kanagawa, Japan, born on February 7, 1961,

especially to perform, on behalf of me and in my name, all formalities and actions in favor of and relating to Japanese patent application No. 321,902/99 dated November 12, 1999 and No. 330,859/00 dated October 30, 2000, already filed or still to be filed on all inventions of the late Takeo KAMIYA during his service with "Hoshiden and Philips Display Corporation" of 3-1, Takatsukadai 4-chome, Nishi-ku, Kobe-shi, Hyogo, Japan;

私の代理として及び私の名前において、故 神谷 長生が日本国兵庫県神戸市西区高塚台 4 丁目３－１に所在の「ホシデン・フィリップス・ディスプレイ株式会社」に在職中になしたすべての発明に基づいて出願された、またはなお出願される、平成１２年１１月１２日に出願された日本国の平成１１年特許願第３２１９０２号及び平成１３年１０月３０日に出願された特願２０００－３３０８５９の為の、及びそれに関するすべての方式手続及び行為をなすこと、

to deliver documents or to perform acts relating to the Industrial Property of "Koninklijke Philips Electronics N.V.";

「コーニンクレッカ フィリップス エレクトロニクス エヌ ヴィ」所有の知的財産に関する書類を届けること、あるいはそれに関する手続をとること、

to have all deeds and document necessary for this purpose laid down and to sign them and to perform all such further acts that could be useful and desirable for such purpose.

ここに定められた目的の為に必要なすべての証書及び書類を有すること及びそれらに署名し、その目的の為に役立つまたは好ましいあらゆる行為をなすこと。

All of the above with the power of substitution.

上記のことはすべて代理権を伴う。

RECEIVED
AUG 24 2001
OIPE/JC05

Date: April 18, 2001

Signature: Akira Kamiya

Akira KAMIYA

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER PHJP000026 US

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **"Liquid crystal display device"**
the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No _____

on _____

and was amended

on _____

☒ was filed as PCT international application

Number PCT/EP00/11288

on 10 November 2000

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Japan	**321,902/99**	**12 November 1999**	**YES**
Japan	**330,859/00**	**30 October 2000**	**YES**

（２の１）　全部事項証明

本籍	愛知県安城市東栄町三丁目１５番地４
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婚姻	【婚姻日】昭和３３年１月２９日 【配偶者氏名】手江ゆき子 【送付を受けた日】昭和３３年２月３日 【受理者】愛知県名古屋市中区長 【従前戸籍】愛知県碧海郡高岡町大字一本木字朝日１９番地　神谷次郎
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発行番号　00041422

以下次頁

全部事項証明

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	以下余白

発行番号　00041422

これは，戸籍に記録されている事項の全部を証明した書面である。

平成１３年４月５日

愛知県安城市長　杉浦　正行　（安城市役所北部出張所長専用）

(Translation)

(1 of 2) Certificate of All Particulars

Legal Residence	15-4, Tobi-cho 3-chome, Anjo-shi, Aichi
Name	KAMIYA, Akira
Particulars of Family Register Change of Family Register	[Date of Change] February 11, 2000 [Reason for Change] Change under Additional Clause No. 2(1) of Ordinance No. 51 of the Ministry of Justice of 1994
Person registered on The Family Register	[Name] AKIRA [Date of Birth] November 7, 1930 [Type of Spouse] Husband [Father] KAMIYA, Jiro [Mother] KAMIYA, Masa [Family Relationship] Second Son
Particulars of Identity Birth	[Date of Birth] November 7, 1930 [Place of Birth] Takaoka-mura, Hekikai-gun, Aichi [Date of Notification] November 10, 1930 [Informer] Father [Date of Receipt of the Notification] November 11, 1930 [Recipient] Head of Takaoka-mura, Hekikai-gun, Aichi
Marriage	[Date of Marriage] January 29, 1958 [Name of Spouse] USHIE, Yukiko [Date of Receipt of Notice] February 3, 1958 [Recipient] Head o f Naka-ku, Nagoya-shi, Aichi [Previous Family Register] KAMIYA, Jiro 19, Aza-asahi, Oaza-ippongi Takaoka-cho, Hekikai-gun, Aichi
Person registered on The Family Register	[Name] YUKIKO [Date of Birth] February 17, 1933 [Type of Spouse] Wife [Father] USHIE, Hiroharu [Mother] USHIE, Tbe [Family Relationship] First Daughter
Particulars of Identity Birth	[Date of Birth] February 17, 1933 [Place of Birth] Ujiyamada-shi, Mie [Date of Notification] February 25, 1933 [Informer] Father [Date of Receipt of the Notification] February 28, 1933 [Recipient] Head of Ujiyamada-shi, Mie
Marriage	[Date of Marriage] January 29, 1958 [Name of Spouse] KAMIYA, Akira [Date of Receipt of Notice] February 3, 1958 [Recipient] Head of Naka-ku, Nagoya-shi, Aichi [Previous Family Register] USHIE, Yukiko 209-1, Kurose-cho, Ise-shi, Mie

(Translation)

(2 of 2) Certificate on All Particulars

Person registered on The Family Register	[Name] TAKEO [Date of Birth] August 17, 1961 [Father] KAMIYA, Akira [Mother] KAMIYA, Yukiko [Family Relationship] First Son
Particulars on Identity Birth	[Date of Birth] August 17, 1961 [Place of Birth] Ise-shi, Mie [Date of Notification] August 25, 1961 [Informer] Father [Date of Receipt of the Notification] August 31, 1961 [Recipient] Head of Ise-shi, Mie
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Publication No. 00041422

This is the certificate of all particulars registered on the Family Register.

April 5, 20001

Mayor of Anjo-shi, Aichi SUGIURA, Masayuki (Seal)

Registered No. 149 (in 2001)

NOTARIAL CERTIFICATE

This is to certify that Mr. Akira Kamiya has affixed his signature in my very presence to the attached document.

Dated this 18 day of April 2001.

Hidetoshi Koura

Notary, attached to

Nagoya Legal Affairs Bureau.

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Nagoya, Japan.

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NAGOYA LEGAL AFFAIRS BUREAU
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International Bureau

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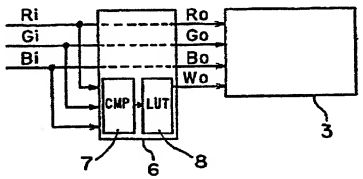
(54) Title: LIQUID CRYSTAL DISPLAY DEVICE WITR HIGH BRIGHTNESS



(57) Abstract: This invention relates to an RGBW-typed LCD wherein a proper luminous image can be displayed according to a predetermined calculation with a decoder where some predetermined calculation formulas are embedded. Further, not only RGBW image display but also RGB image display can be used by a predetermined controlling signal.

WO 01/37251 A1

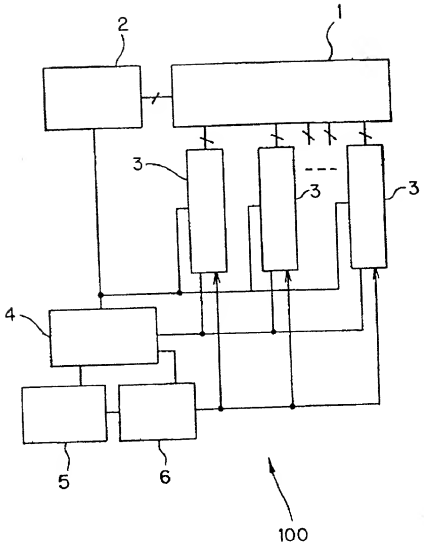


FIG. 1

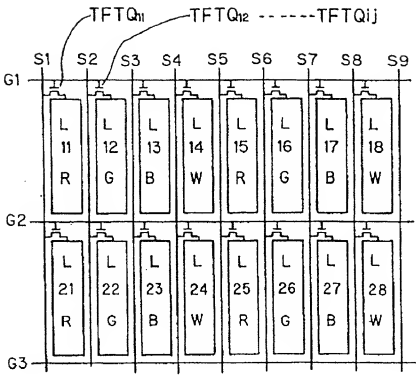

TFTQ11
TFTQ12
TFTQij
S1
S2
S3
S4
S5
S6
S7
S8
S9
G1
G2
G3
L 11 R
L 12 G
L 13 B
L 14 W
L 15 R
L 16 G
L 17 B
L 18 W
L 21 R
L 22 G
L 23 B
L 24 W
L 25 R
L 26 G
L 27 B
L 28 W

FIG. 2

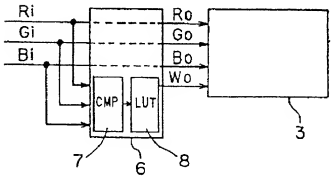
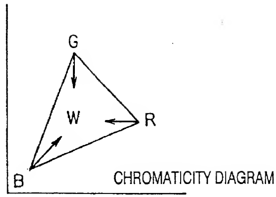
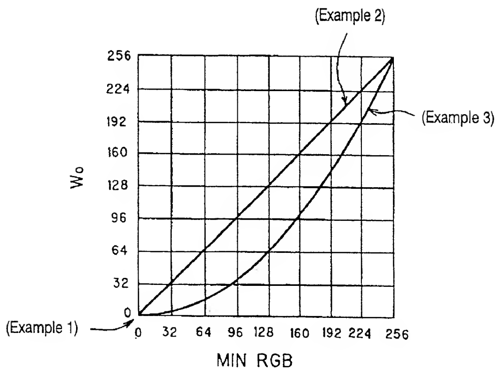

Ri
Gi
Bi
Ro
Go
Bo
Wo
CMP
LUT
7
6
8
3

FIG. 3


G
W
R
B
CHROMATICITY DIAGRAM


(Example 2)
(Example 3)
(Example 1)
256
224
192
160
128
96
64
32
0
Wo
0 32 64 96 128 160 192 224 256
MIN RGB

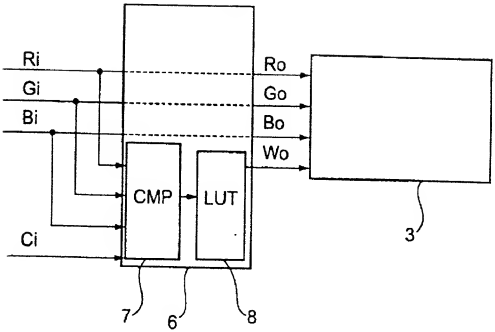

Ri
Gi
Bi
Ci
CMP
LUT
Ro
Go
Bo
Wo
3
7
6
8

FIG. 6

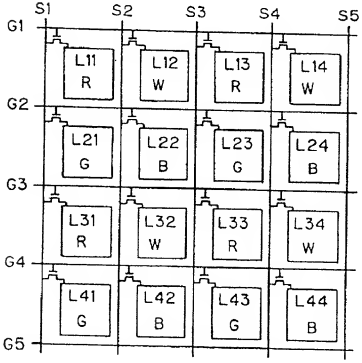

S1
S2
S3
S4
S5
G1
G2
G3
G4
G5
L11 R
L12 W
L13 R
L14 W
L21 G
L22 B
L23 G
L24 B
L31 R
L32 W
L33 R
L34 W
L41 G
L42 B
L43 G
L44 B

FIG. 7

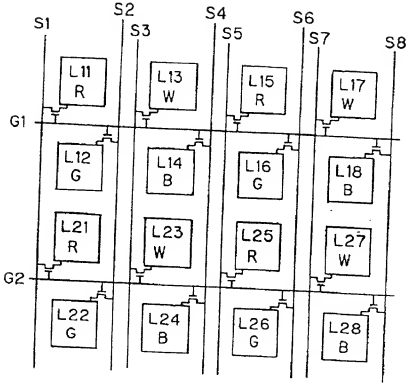

S1
S2
S3
S4
S5
S6
S7
S8
G1
G2
L11 R
L13 W
L15 R
L17 W
L12 G
L14 B
L16 G
L18 B
L21 R
L23 W
L25 R
L27 W
L22 G
L24 B
L26 G
L28 B

FIG. 8

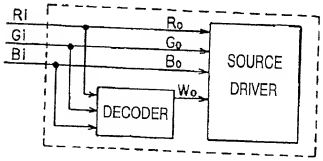

RI
GI
BI
Ro
Go
Bo
Wo
DECODER
SOURCE DRIVER

FIG. 9